CRITERIA AND PROCESSES FOR THE CERTIFICATION OF NON-RADIOACTIVE HAZARDOUS AND NON-HAZARDOUS WASTES

January 2009

LLNL-TR-409583
By J. Dominick Lawrence Livermore National Laboratory

DISCLAIMER

This work was performed under the auspices of the U. S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

DOE Approvals Page

Criteria and Processes for the Certification of Non-Radioactive Hazardous and Non-Hazardous Wastes

January 2009

Approved by: _____ Date: _____

Ms. Alice Williams:
Livermore Site Office Manager

LLNL Approvals Page

Criteria and Processes for the Certification of Non-Radioactive Hazardous and Non-Hazardous Wastes

January 2009

Author: _____ Date: _____

Jared Dominick:
Subject Matter Expert
Radiological Characterization Group

Approved by: _____ Date: _____

Brian Perkins:
Division Leader - Radioactive and Hazardous Waste Management

Approved by: _____ Date: _____

Stephanie Goodwin:
Technical Advisor - Nuclear Materials Technology Program

Approved by: _____ Date: _____

Mark Martinez:
Deputy Principal Associate Director - Weapons and Complex Integration

CONTENTS

TABLES

THIS PAGE LEFT INTENTIONALLY BLANK

I. INTRODUCTION

This document details Lawrence Livermore National Laboratory's (LLNL) criteria and processes for determining if potentially volumetrically contaminated or potentially surface contaminated wastes are to be managed as material containing residual radioactivity or as non-radioactive. This document updates and replaces UCRL-AR-109662, *Criteria and Procedures for the Certification of Nonradioactive Hazardous Waste* (Reference 1), also known as "The Moratorium", and follows the guidance found in the U.S. Department of Energy (DOE) document, *Performance Objective for Certification of Non-Radioactive Hazardous Waste* (Reference 2).

The 1992 Moratorium document (UCRL-AR-109662) is three volumes and 703 pages. The first volume provides an overview of the certification process and lists the key radioanalytical methods and their associated Limits of Sensitivities. Volumes Two and Three contain supporting documents and include over 30 operating procedures, QA plans, training documents and organizational charts that describe the hazardous and radioactive waste management system in place in 1992. This current document is intended to update the previous Moratorium documents and to serve as the top-tier LLNL institutional Moratorium document.

The 1992 Moratorium document was restricted to certification of Resource Conservation and Recovery Act (RCRA), State and Toxic Substances Control Act (TSCA) hazardous waste from Radioactive Material Management Areas (RMMA). This still remains the primary focus of the Moratorium; however, this document increases the scope to allow use of this methodology to certify other LLNL wastes and materials destined for off-site disposal, transfer, and re-use including non-hazardous wastes and wastes generated outside of RMMAs with the potential for DOE added radioactivity. The LLNL organization that authorizes off-site transfer / disposal of a material or waste stream is responsible for implementing the requirements of this document. The LLNL Radioactive and Hazardous Waste Management (RHWM) organization is responsible for the review and maintenance of this document.

It should be noted that the DOE metal recycling moratorium is still in effect and is implemented as outlined in reference 17 when metals are being dispositioned for disposal / re-use / recycling off-site.

This document follows the same methodology as described in the previously approved 1992 Moratorium document. Generator knowledge and certification are the primary means of characterization. Sampling and analysis are used when there is insufficient knowledge of a waste to determine if it contains added radioactivity.

Table 1 (page 12) presents a list of LLNL's analytical methods for evaluating volumetrically contaminated waste and updates the reasonably achievable

analytical-method-specific Minimum Detectable Concentrations (MDCs) for various matrices. Results from sampling and analysis are compared against the maximum MDCs for the given analytical method and the sample specific MDC to determine if the sample contains DOE added volumetric radioactivity.

The evaluation of an item that has a physical form, and history of use, such that accessible surfaces may be potentially contaminated, is based on DOE Order 5400.5 (Reference 3), and its associated implementation guidance document DOE G 441.1-XX, *Control and Release of Property with Residual Radioactive Material* (Reference 4). The guidance document was made available for use via DOE Memorandum (Reference 5).

Waste and materials containing residual radioactivity transferred off-site must meet the receiving facilities Waste Acceptance Criteria (if applicable) and be in compliance with other applicable federal or state requirements.

Additionally, this document updates the original Moratorium (UCRL-AR-109662) in the following ways:

- It clarifies that this document is not restricted to RCRA, State or TSCA hazardous waste and may be used to certify the radioactive content of any waste for off-site disposal.
- It describes the qualifications of analytical facilities that provide analysis in support of this determination to allow the use of approved off-site commercial laboratories and additional on-site LLNL radiochemistry laboratories
- It strengthens the use of virgin material analysis for determining radioactivity in difficult to analyze matrices, or matrices containing naturally occurring radioactivity. This includes analysis of materials of the same matrix that have never been exposed to radioactivity to determine if the waste sample contains DOE-added radioactivity.
- It eliminates the phrase “Action Limit” and identifies that Table 1 values are not release limits, but sensitivity requirements, which better reflect the true analytical MDCs that LLNL can reasonably achieve based upon operating experience since 1992.
- It describes alternative methods of determining added radioactivity in certain special case wastes, including high explosives, mercury, and HEPA filters.

II. SCOPE AND APPLICABILITY

This document applies to all waste slated for off site disposal or transfer that has a reasonable potential for, or is suspected of having, radioactive contamination on the surface or in volume. While it is intended to predominantly cover waste from RMMAs, it may be applied as necessary to wastes from areas that are not currently RMMAs, but are known to have, or are suspected of having, conducted radiological operations in the past. In addition, it applies to wastes for which the disposal fate is unknown. This document may also be applied to materials transferred off-site for re-use or recycle with the potential for DOE added radioactivity. This document does not apply to on-site transfer of materials or to materials to be reused on-site.

Discarded “source material” as defined by the Atomic Energy Act, which includes uranium and thorium, or chemical compounds or commercial articles with identified uranium or thorium content are to be treated as radioactive regardless of how they were procured, stored, or handled. While specific exemptions may apply, the use of such exemptions must be approved by RHWM (with Livermore Site Office concurrence), and documented on a case-by-case basis. When practical, these materials and other manufactured items containing radioactivity may be returned to the manufacturer.

The release of radioactive waste in a gaseous form is beyond the scope of this document.

III. ACRONYMS AND DEFINITIONS

AL	Authorized Limit
ASTM	American Society for Testing Materials
EA	Environmental Analyst
EPA	Environmental Protection Agency
GAB	Gross Alpha / Beta analysis
HEPA	High Efficiency Particulate Air
HP	Health Physicist
LSC	Liquid Scintillation Counting
LTRAIN	Livermore Training Records and Information Network
NRC	Nuclear Regulatory Commission
POTW	Publicly Owned Treatment Works
QAIC	Quality Assurance Implementation Coordinator
RCG	Radiological Characterization Group
RCGA	Radiological Characterization Group Analyst

RDWG	DOE Research and Development Laboratory Working Group
RHWM	Radioactive and Hazardous Waste Management
SCO	Surface Contaminated Objects

Authorized Limit	A limit on the concentrations of residual radioactive material on the surfaces of or within property that has been derived consistent with the low as reasonably achievable (ALARA) process, given the anticipated use of the property (either restricted or unrestricted), and that has been authorized by the Department of Energy to permit the release of the property from DOE control.
Authorized Reviewer	An individual with the appropriate background and training authorized by LLNL to prepare and sign Rad Declarations (Rad Dec) per the guidance in this document and applicable procedures.
LRC	Limited Radiological Certification. A form completed and signed by the waste generator and Health Physicist (HP), which certifies that only certain radioisotopes are possibly present in a waste.
MDA	Minimum Detectable Activity. For the purposes of this document, this is defined as Curie's L_D. A calculated value of the lowest activity that can be detected in a specific sample within a 95% confidence interval, given a specified background count rate, efficiency, chemical yield, and sample size.
MDC	Minimum Detectable Concentration. The MDA corrected for sample size.
NORM	Naturally-Occurring Radioactive Material. An example is K-40 or Th-232+D present in soil with no contribution from man-made sources or DOE operations.
NRA	No Radioactivity Added. A sample that has met the requirements of this document for having no measurable radioactivity added as a result of DOE activities.
Rad Declaration	(Rad Dec). A documented determination of whether a sample has added radioactivity as a result of DOE activities. Results may be NRA or Rad-Added.
RMA	Radioactive Material Area. Any area within a controlled area, accessible to individuals, where items or containers of radioactive material exist and the total activity of radioactive material exceeds the applicable values provided in the

	ES&H Manual, Document 20.2, Appendix E, *Values for Establishing Sealed Radioactive Source Accountability and Radioactive Materials Posting and Labeling Requirements* (Reference 6).
RMMA	Radioactive Materials Management Area. A workspace at LLNL in which the potential exists for contamination due to the presence of un-encapsulated or unconfined radioactive material, or an area that is exposed to beams or other sources of particles capable of causing activation.
SOW	Statement of Work. The Statement of Work for Analytical Services in Support of Lawrence Livermore National Laboratory.

IV. ROLES AND RESPONSIBILITIES

The **RHWM** organization is responsible for control of this document.

The **Area Health Physicist (HP)** is responsible for being aware of which areas in a facility are working with radioactive materials, and which areas have dispersible radioactive materials. The HP is responsible for adding and removing RMMAs from the RMMA list as they are posted or de-posted. The HP may assist in determining which analyses shall be performed, based on the nuclides used in a given area.

The **Radiological Characterization Group Analyst** (**RCGA),** or equivalent, is responsible for evaluating if generator knowledge is sufficient to characterize a waste for radioactivity content. This includes cases where waste has been generated that may not come from a single process, or have a well-defined generator (including legacy and facility-related waste). The RCGA may assist in determining which analyses shall be performed, based on process knowledge, including the history of nuclides used in a given area.

The **Authorized Reviewer** is responsible for evaluating characterization data in order to determine if a waste sample may be certified to be free of DOE added radioactivity and completing the Rad Dec.

The **RHWM Field Technician**, or equivalent, assists the generator in characterizing wastes, and arranges for sampling and analysis of potentially contaminated wastes.

The **RHWM Sampling Team**, or equivalent, is responsible for the sampling of bulk wastes.

The **Waste Generator** is responsible for certifying that a waste contains, does not contain, or may possibly contain, radioactive constituents from LLNL activities. The Waste Generator is responsible for specifying which radioisotopes are used in particular areas or processes.

V. USE OF EXISTING REGULATIONS, ORDERS, AND STANDARDS AS AUTHORIZED LIMITS

The Performance Objective (Reference 2), states that "A radioactive waste is any waste managed for its radioactive content which is not otherwise regulated for that radioactive content (e.g., regulated by Clean Air Act, etc.). If a material was received as nonradioactive, any resulting waste is not a radioactive waste if it meets the following conditions: 1. Contains no measurable increase in radioactivity (at a statistically defined confidence interval) above background in volume or bulk resulting from DOE Operations except for wastes specifically exempted or excepted by the Environmental Protection Agency (EPA), DOE, or NRC regulations (e.g., 10 CFR 20.2005); and 2. Complies with the surface contamination requirements established in DOE Order 5400.5, 11.5.c. (1)". This portion of the Performance Objective allows invocation of other regulatory exemptions or exceptions with DOE approval (see #3 below).

Wastes which satisfy the requirements of any of the following regulations and DOE Orders may be released from radiological controls.

1. Are of a form and history of use such that only surface contamination is possible, and meet the surface contamination release limits of DOE Order 5400.5. Materials with known surface contamination shall be decontaminated to levels that are as low as is reasonably achievable. See Section XIV for additional discussion.

2. Meet the City of Livermore Wastewater Discharge Permit for wastewaters sent to the sanitary sewer (Publicly Owned Treatment Works).

3. Meet radioactivity limits established by federal or state regulatory agencies (Nuclear Regulatory Commission, EPA and/or State Department of Health Services), and approved by DOE. See Memo from Nakahara to Crawford (1993), approving the use of 10 CFR 20.2005 (Reference 7).

Note that release of materials under these requirements is conducted under an Authorized Limit (AL) which is not the same as a no-radioactivity-added (NRA) determination. Authorized Limits are authorized release limits for effluents containing residual radioactive material and may require additional approvals by the receiving facility and the receiving facilities regulating agency. Before effluents leave the site under an AL, the AL must be approved and documented.

Waste being transferred off-site under an AL must be certified to the AL under which it is being approved for release.

VI. OVERVIEW OF WASTE CHARACTERIZATION PROCESS

While this process is primarily intended to address waste generated in an RMMA, it also applies to materials for which the disposition is unknown. It further applies to wastes from areas that may not be current RMMAs, but have been RMMAs in the past, that are associated with radioactive systems, or where the history of use of radioactive materials is unknown or uncertain.

Generator certification is the primary means by which waste is characterized for radioactive content. Individuals making this determination will be trained in accordance with Section IX, Waste Generator Training. Generators must have full knowledge of the constituents and generating process of a waste to certify its radioactive content. In cases where no knowledgeable generator can be identified, or the RHWM Field Technician and the RCGA determine that there is insufficient knowledge of a waste generating process to have a high degree of confidence in generator certification, sampling and analysis for volumetric and/or swipe/survey for surface contaminated objects (SCOs) will be required to determine if a waste is to be managed as radioactive or non-radioactive.

Generator certification as the sole means of characterizing radiological content should be reserved only for potentially volumetrically contaminated materials. Suspect SCOs shall undergo swipe and survey.

In cases where a knowledgeable and trained generator exists, the generator will certify that the waste is 1) non-radioactive, 2) radioactive, or 3) cannot be determined. The generator will perform this certification in accordance with Section VIII, Generator Certification of Waste, below.

If the waste is certified non-radioactive, it will be managed as required by its non-radioactive properties. This waste is then released from radiological controls with respect to disposal.

If the waste is certified radioactive, the radioactivity will be characterized for management purposes, and the waste will be managed as material containing residual radioactivity (per DOE O 5400.5) or radioactively contaminated (per DOE O 435.1 [Reference 8]).

If the generator cannot certify the waste as radioactive or non-radioactive, the waste will be sampled and analyzed for radioactivity. Since LLNL has historically used a variety of isotopes, no one type of radioanalytical analysis will detect all possible nuclides. Samples will typically be analyzed for alpha emitters (gross alpha), medium-to-high energy beta emitters (gross beta), and tritium (by LSC).

In a subset of cases where the generator can certify that only a single or few nuclides could possibly be present, a subset of analyses, or special analytical techniques may be performed. Isotopic analysis, or other appropriate analytical techniques may be employed to detect the presence of suspected specific isotopes which are not readily quantifiable through the standard set of analysis.

When analytical data is available for the waste, an Authorized Reviewer will compare the radioanalytical results to the sample's Minimum Detectable Concentration (MDC) to determine if radioactivity has been added to the sample. Sample results that are above the sample's MDC will be declared "rad-added" or "Containing Residual Radioactivity", and the waste represented by that sample, managed under a DOE-approved AL or as radioactive waste. If the sample results are not above the sample specific MDC, the sample will be declared "no-radioactivity-added" (NRA) and the waste represented by this sample may now be released from radiological controls.

VII. MANAGEMENT OF RMMAs

RMMAs are areas where the potential exists for contamination due to the presence of un-encapsulated or unconfined radioactive material, or an area that is exposed to beams or other sources of particles (neutrons, protons, etc.) capable of causing activation. The HP is responsible for determining if a workplace is an RMMA. This determination is based on the area HP's knowledge of the activities occurring in the workplaces, and discussions with generators. Radioactive Materials Management Areas are designated with signs, and a list is maintained and distributed by the Hazards Control Department. Areas may be changed from RMMA to non-RMMA and vice versa as activities in the workplace change and potential sources of contamination are added or removed.

VIII. GENERATOR CERTIFICATION OF WASTE

Generator certification is the primary means of determining whether waste is to be managed as radioactive or non-radioactive. By certifying the waste as no-radioactivity-added (NRA), the generator is stating that he/she has a high degree of confidence that the waste has not been contaminated by radioactive materials, either because radioactive materials are not used in the area where the waste was generated, or the waste was kept isolated from radioactive materials such that it cannot be contaminated by them. The generator is also certifying that the waste has not been exposed to beams or particles (e.g. neutrons) capable of activating the waste. In order to certify a waste as NRA, the generator must meet two criteria;

1. They must be trained as an LLNL waste generator.

2. They must be adequately knowledgeable about the waste, including its history and constituents.

Generator training is described in the next section. Adequate knowledge means that the generator knows the constituents of the waste, knows and understands the process that generated the waste, and knows the history of the waste, either through direct knowledge, or from gathering sufficient information from others familiar with the waste and process. If a knowledgeable generator cannot certify the waste, it shall either be managed as radioactive, or sampled and analyzed for radioactivity according to the requirements of this document.

The RHWM Waste Disposal Requisition (WDR) Certification is the primary document for certifying waste. While the question numbers and actual wording below may change with future versions of the WDR, the intent of the following questions will be maintained.

The initial question is:

"Does this waste contain radioactive materials? ☐ *Yes* ☐*No* ☐ *To be analyzed."*

By answering Yes, the generator is certifying that the waste is to be managed as radioactive, and the type and quantity of activity are then determined for management purposes. By answering No, the generator is certifying that the waste does not contain DOE added radioactivity, and should be managed as non-radioactive. By certifying To Be Analyzed, the generator is stating that they are uncertain as to whether the waste contains added radioactivity, and the waste should be analyzed to determine whether it should be managed as radioactive or non-radioactive.

The next certification question is:

"RMMA: ☐ *Yes* ☐*No."*

This question asks the generator whether the waste was generated in a Radioactive Materials Management Area. If the answer to this question is Yes, and the waste is not radioactive, the generator must also answer the following questions:

"Was the waste possibly exposed to a process resulting in radioactive contamination? ☐ *Yes* ☐*No"*

"Was the waste exposed to radioactive inducing particle beams? ☐ *Yes* ☐*No."*

Finally, the generator must sign the following certification statement:

> *"I certify, to the best of my knowledge, that the information provided on this requisition is correct. I understand that I may be liable to State and Federal prosecution by intentionally providing false information. I have obtained this information by*
>
> ☐ *Direct knowledge of the generating process;*
> ☐ *Analytical Data;*
> ☐ *Obtaining sufficient information from others knowledgeable of the waste process."*

In a limited subset of cases, a generator may not be able to certify that a waste is free of added radioactivity, but may be able to certify that only a single isotope or limited group of isotopes is used in the work area, or, conversely, that certain isotopes are definitely *not* used in a work area. In these cases a generator, with the assistance of the area HP or RCGA, may fill out a Limited Radiological Certification (LRC) form. With this LRC form, testing for radioisotopes known to be absent may be eliminated.

Not all waste materials transferred off-site are documented on an RHWM WDR. Where applicable, requirements, procedures, and processes to characterize, track, and certify these materials should be documented and traceable to the material being transferred off-site. These controls as well as applicable training requirements should be documented by the organization responsible for the material or waste being transferred off-site.

IX. WASTE GENERATOR TRAINING

Waste generators who certify the radioactive nature of waste generated in an RMMA are trained in the identification and characterization of waste types, waste certification requirements, and the waste management process. For wastes processed through RHWM, the primary document describing the waste is the WDR. In order to sign a Waste Disposal Requisition (WDR), a generator must be current in the appropriate training for the specific waste type.

X. REQUIREMENTS FOR ANALYSIS FOR RADIOACTIVITY

Sampling of bulk wastes shall be performed by trained technicians using written sampling procedures appropriate for the waste being sampled. Sampling activities shall be documented and procedurally controlled. The organization authorizing the off-site disposal of the waste is responsible for the collection of appropriate and representative samples.

The process described in this document applies to a specific sample, not a waste stream. Application of the results of a given sample to multiple containers, or a complete waste stream, requires additional analysis and control which is beyond the scope of this document, but is provided in the waste specific characterization documentation package.

Analysis of bulk samples for volumetric radioactivity, shall be performed by laboratories that can meet the MDCs in Table 1. Off-site commercial analytical laboratories under contract with LLNL work to an approved Statement of Work for Analytical Services (Reference 11), which includes documented requirements for analytical methods and the associated detection limits. Samples may also be analyzed by on-site LLNL laboratories that operate under an approved quality assurance plan and operating procedures, and produce data that is scientifically valid, legally defensible, and of known precision and accuracy. On-site laboratories generating data used for rad declarations must undergo periodic internal or external assessment, be accredited, or participate in a sample exchange program. All analyses shall be performed in accordance with established procedures from recognized organizations such as the American Society for Testing Materials (ASTM)/DOE/Environmental Protection Agency (EPA) or equivalent. Transmitted results shall include measured values and sample-specific minimum detectable activity concentration values for each analysis.

XI. PERFORMANCE CRITERIA FOR RADIOANALYTICAL METHODS USED TO MEASURE VOLUMETRIC CONTAMINATION

The radiochemical methods used to measure potential volumetric contamination must meet minimum performance standards. These standards are based upon achievable MDCs for real samples. A large sample of data from a three year period of waste analysis was analyzed to determine the average sample size, detection efficiency, and MDC for different matrices (*Technical Basis Document for Criteria and Processes for the Certification of Non-Radioactive Hazardous and Non-Hazardous Wastes* [Reference 14]). These samples were analyzed by Chemistry and Material Science Environmental Services.

The MDC values are listed for five matrices (aqueous, oils, solvents, coolants, and solids/sludges). Aqueous samples analyzed for radioactivity show two distinct populations; a group of “clean matrix” and a group of “dirty matrix” aqueous samples, as defined in Table 1. Coolants that are analyzed are treated as “dirty matrix” aqueous samples, and have MDCs similar to this group.

The following maximum MDC values in Table 1 define the minimum acceptable analytical sensitivity of the radiochemical methods used for NRA determinations. Table 1 reflects actual detection limits that can be achieved with real samples. The intent of the table is to establish a minimum performance level for

radioanalytical methods in support of evaluating waste material. The actual MDC for a given sample should be equal to or less than the appropriate value in Table 1 with the exception of cases in Section XIII.

Table 1. Maximum MDC Values for Radioanalytical Methods for LLNL Samples

	Gross α	Gross β	Tritium
Aqueous (AQ) "Clean Matrix" RT, Berms, Rain water	**20 pCi/L** 100 min count*	**60 pCi/L** 100 min count*	**3000 pCi/L** 50 min count*
Aqueous (AQ) "Dirty Matrix" Spent chemicals, mop water Coolants	**1500 pCi/L** 100 min count*	**2000 pCi/L** 100 min count*	**3000 pCi/L** 50 min count*
Oil (OI)	**5000 pCi/L** 100 min count*	**10,000 pCi/L** 100 min count*	**40,000 pCi/L** 50 min count*
Solids, Sludges (SO, SL, XX)	**6 pCi/gm** 100 min count*	**10 pCi/gm** 100 min count*	**5 pCi/gm** 50 min count*
Solvents (SV)	**1500 pCi/L** 100 min count*	**2000 pCi/L** 100 min count*	**40,000 pCi/L** 50 min count*

* Count times are estimates of the count times needed to achieve the required MDA. These specific times are not required. Achieving the MDC is required regardless of count time. See Section XIII for exceptions.

XII. DETERMINATION OF ADDED VOLUMETRIC RADIOACTIVITY

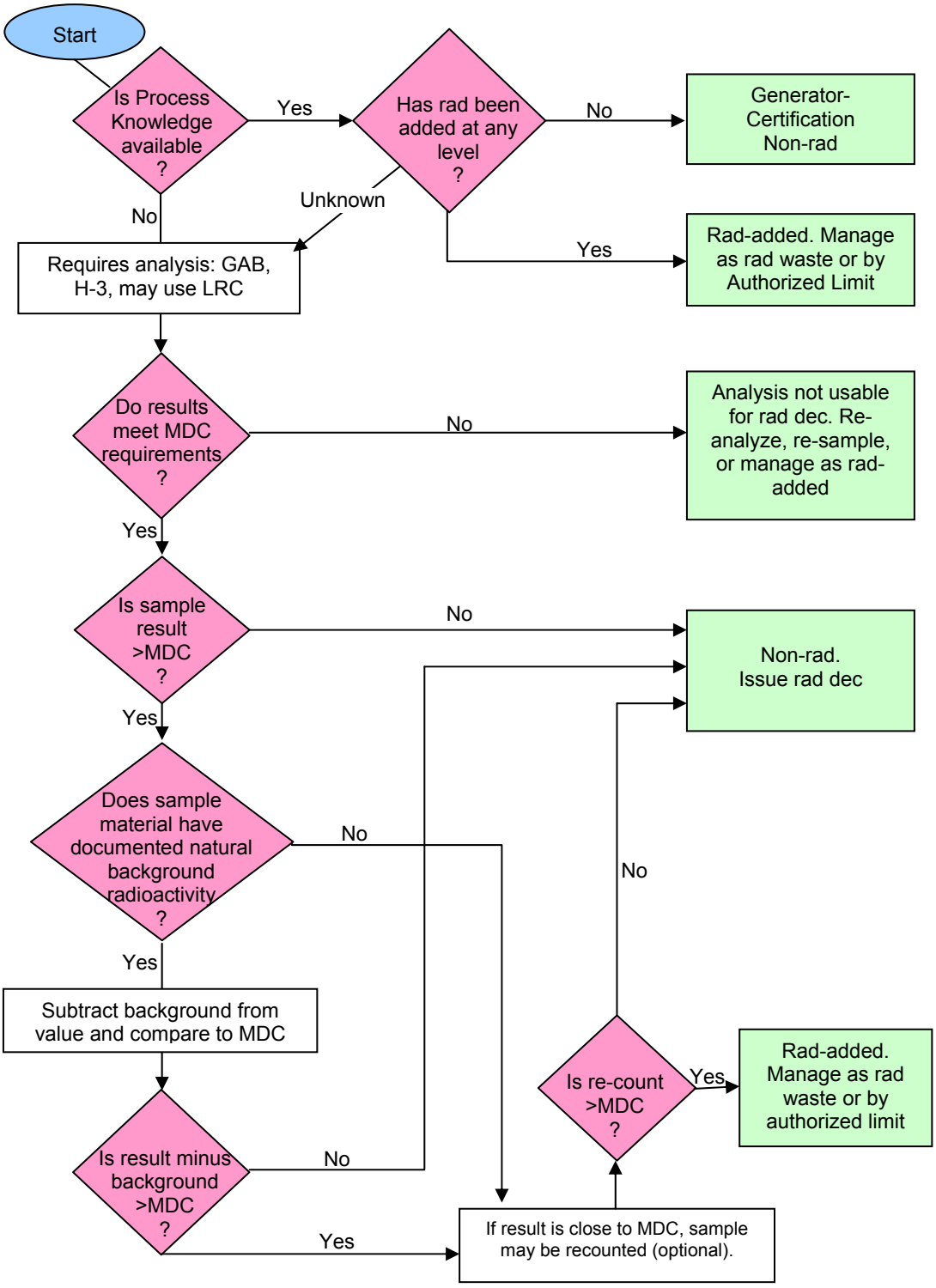
When radioanalytical data is available, the data will be compared to the Table 1 MDCs for that matrix (given in Table 1 above), the sample specific MDC, and any information regarding natural radioactivity present in the material. The Authorized Reviewer will evaluate this information and determine if the sample is to be managed as rad-added or non-radioactive. RHWM procedure WIC-148, *Review of Radiochemical Data for Determination of Added Radioactivity* (Reference 9), or equivalent procedure, gives the requirements and steps taken to make this determination.

In order for a sample result to receive an NRA determination, the radiochemical method used to analyze the sample must achieve a sample MDC equal to or lower than the value in Table 1. For material with no detectable natural radioactivity, the sample results must be Non-Detect when compared to the sample specific MDC. For single results that are slightly above the MDC, the sample may be re-analyzed a second time to determine if the first analysis was a "false positive". If the subsequent analysis meets the target MDC and is a non-detect, an NRA determination may be assigned. If the subsequent analysis meets the target MDC and contains detectable activity greater than the sample specific MDC, the sample will be determined to have "Rad-Added".

Waste designated as "Rad Added" or "Containing Residual Radioactivity" may be managed through the AL process or managed as radioactive waste.

The following flowchart outlines the general process for evaluating the presence of volumetric DOE-added radioactivity.

General Process* for Evaluating the Presence of Volumetric DOE-Added Radioactivity



*Note: Alternative sample evaluation approaches (e.g., for HEPA filters, metal analysis) may be authorized.

XIII. SPECIAL CASE WASTES

Highly Toxic or Potentially Reactive Wastes

If a sample is of such high toxicity and/or reactivity to preclude sample digestion for routine gross alpha/beta analysis via the gas proportional counting method due to increased personnel and infrastructure hazards, the sample may be analyzed via a combination of generator knowledge and other techniques, including liquid scintillation counting and/or gamma spectroscopy (in cases where all expected contaminants are gamma emitters). Liquid mercury and high explosive residues are examples of matrices commonly analyzed via this method.

Due to limitations in the sample aliquot size that may be safely processed for difficult matrices, the MDC values identified in Table 1 may not be achievable for some wastes, particularly those with large amounts of dissolved solids. In these cases, the actual sample-specific MDC will be used for determining whether the sample is radioactive or not, and the limits for declaration of added radioactivity will default to the sample-specific MDC. Samples with an MDC greater than 10 times the Table 1 value for the matrix of concern will not be used for NRA determinations.

Wastes Containing Naturally-Occurring Radioactive Material (NORM)

Many elements have naturally occurring primordial and/or cosmogenic radioisotopes, which contribute to the radioactivity in waste samples. The majority of these wastes do not contain “DOE added radioactivity.” Examples of these include potassium chloride (KCl), a common salt substitute, which produces an easily measurable radiation field, or Be-7, a short-lived cosmogenic nuclide, in High Efficiency Particulate Air (HEPA) filters. NORM, which is incidental to the matrix being analyzed, may be subtracted from the total radioactivity and treated as background when making the determination of “DOE added radioactivity.”

One way to do this is to take the potassium concentration of the sample, from total metals analysis, and calculate the expected gross beta activity, then determine if the measured gross beta can be accounted for by the quantity of potassium. For materials with significant concentrations of potassium, the naturally present K-40 will give rise to detectable gross beta activity. The authorized reviewer may calculate an expected gross beta activity using the elemental potassium concentration, an assumed natural K-40 abundance of 0.0117 atom%, and the half life. The calculated beta activity contribution from K-40 is subtracted from the sample gross beta result and if this value is less then the sample specific MDC the sample may be deemed NRA.

An alternative method is based on the analysis of "virgin" or "blank" materials, of the same or similar matrix to the waste, but known to be uncontaminated and determining the incidental natural occurring radioactivity for each matrix or material type.

For commonly-measured matrices where NORM or sample size make it difficult to determine whether radioactivity was added, such as mop water and machine oils, a blank material or background study may be performed by analyzing a set of samples from matrices or areas known to have never been associated with radioactive materials work. The number of background samples will determined on a case-by-case basis depending on the variability of the blank matrix. The average value and standard deviation of the gross alpha, beta, and tritium will be calculated for this set of samples. The results will be documented in a report or memo to file which will be referenced in or attached to Rad Declaration. These background values will be used to determine if the waste contains added radioactivity. If the measured gross alpha or gross beta is within the range established by the background study, then the measured activities may be assumed to be from natural background radioactivity and the sample deemed NRA. *Background Values of Gross Alpha and Gross Beta in Soil for Lawrence Livermore National Laboratory* (Reference 15), provides an example of how the background evaluation may be conducted.

Soils and Soil-Analogues (Volumetric)

Soils and soil-analogue matrices are defined as unconsolidated soil, gravel, asphalt and concrete, with residual incidental construction debris (e.g. gypsum board, floor tiles, roofing materials, and construction wood). Soil and soil-analogue matrices are expected to contain NORM such as uranium, thorium, and K-40. As such, the criteria for the assessment of radioactive content for these samples follow the recommendations of the subject memo *Report of the ad hoc Committee on Radiological Analyses of Soils and Preconstruction Debris,* from Hall to Isherwood (Reference 13) and the background values established for LLNL main site and site 300 (Reference 15). The release of materials using the values in Table 2 are based upon the assumption that the gross activity contribution is only from naturally occurring radionuclides, and that no DOE added or enhanced radioactivity is present. As identified in the following scenarios, appropriate documentation to support application of this assumption should be maintained. The presence of man-made nuclides as determined through process knowledge or analytical results would preclude the material from being released under the soil screening limits.

Table 2. Screening Limits for NORM in Soils and Soil-analogues (Volumetric)

Criteria	Screening Limit Main Site	Screening Limit Site 300
Gross Alpha	≤6.5 pCi/gm	≤11 pCi/gm
Gross Beta	≤11 pCi/gm	≤21 pCi/gm
Tritium	<MDC@ 5 pCi/g*	<MDC@ 5 pCi/g*

* Natural tritium levels in soil are well below the minimum detectable concentration of 5 pci/g of Table 1. For soils with potential tritium contamination, the sample specific MDC must meet this limit and the sample results must be non-detect for an NRA determination. Tritium detected above the sample specific MDC will be declared "Rad Added" or "Containing Residual Radioactivity".

Non-suspect soils

Non-suspect areas are areas where there is no history of use or contamination with dispersible radionuclides, especially transuranic nuclides. Identification and documentation of non-suspect areas is conducted and documented by the Environmental Operations Division through due diligence evaluations of projects prior to initiation of work. When documented, due diligence evaluations are considered equivalent to a generator NRA certification when coupled with supporting gross analysis. Under this scenario the gross alpha and beta analysis results are compared to Table 2 values. The evaluation of the data is documented and a "Rad Declaration" conducted.

Inconclusive soils

For release of soil from areas where due diligence is inconclusive with respect to added radioactive contamination, gross alpha and gross beta results may be compared to the more restrictive Table 1 values or radionuclide speciation may be conducted to demonstrate only naturally occurring radionuclides and progeny in equilibrium are present. If radionuclide speciation indicates the presence of only naturally occurring radionuclides and progeny, the gross sample results may be compared to the Table 2 values above. The evaluation of the data is documented and a "Rad Declaration" conducted.

Suspect soils

Samples from suspect areas that have a history or significant suspicion of having had spills or contamination incidents in the past shall undergo isotopic analysis for radionuclide speciation in addition to gross alpha and gross beta analysis. If radionuclide speciation indicates the presence of only naturally occurring radionuclides and progeny in equilibrium, the gross sample results may be

compared to the Table 2 values above. The evaluation of the data is documented and a "Rad Declaration" conducted.

Determination of Added Radioactivity for Soils and Soil Analogues
Samples which meet the requirements of this section (meet Table 1 and are non-detect, or measured gross activities meet Table 2 and no man made nuclides are expected/detected as documented on the due diligence certification) will receive an NRA determination. Samples which do not meet Table 2 or contain measurable man-made radioactivity will be determined to be "Rad-Added" or "Containing Residual Radioactivity".

Samples determined to be "Rad Added" or "Containing Residual Radioactivity" may be managed through the AL process, or managed as radioactive waste.

Soil and soil analogues meeting the screening limits for both gross alpha and gross beta, but containing measurable tritium, may be re-used on-site with tritium concentrations not to exceed 300pCi/g. This value is one tenth of the screening value recommended in *Surface and Volume Radioactivity Standards for Clearance* (Reference 16) and equates to a maximum potential dose of 0.1 mRem/yr, which is well within the recommended guidance of 1 mRem/yr for DOE field office authorization and approval.

HEPA Filters

HEPA filters are a particularly difficult matrix to safely analyze destructively. The level of rigor required for determining if a HEPA is to be managed as radioactive depends upon the level of generator knowledge available for the particular ventilation system which the HEPA is associated with. Filters with documented histories of use in facilities known to work only with natural and/or depleted uranium and/or thorium isotopes may be analyzed for radioactivity via a combination of swipe sampling, and gamma spectroscopy. If a swipe sample of the filter inlet shows no measurable removable activity, and a gamma count of the filter shows no detectable activity (with an MDA for 238-Uranium of 1 microCi or less), the filter will be declared non-radioactive. Filters from facilities that have either a poorly-known operating history, or have a history of using isotopes other than uranium or thorium, may not be analyzed via this method, and shall either be sampled destructively and analyzed, or declared radioactive.

Tritium Contaminated Swipeable Matrices

Permeable solid materials (e.g. wood, concrete slabs, wall board, paper) with the potential for tritium contamination (surface and volumetric) may be evaluated for authorized release using swipe techniques as indicated under Section XIV below without having to destructively sample for tritium in volume. This method is not to be used on unconsolidated materials like soil or soil analogues (e.g. gravel, rubbleized concrete). It is important to note that this only applies to tritium. If the

potential exists for volumetric contamination by other radionuclides, due to activation or absorption/saturation with radioactive liquids, sampling and analysis must be conducted and evaluated per the guidelines for volumetric contamination.

XIV. SURFACE CONTAMINATION RELEASE AS AUTHORIZED LIMITS

Solid Waste which only has the potential for surface contamination may be characterized for a Rad-Dec (NRA determination) or authorized release. Solid waste with potential for surface contamination may be evaluated to determine if it meets the Allowable Total Residual Surface Activity values in DOE 441.1-XX, Table 2 (Reference 4). Table 3 lists the specific allowable values for both total and removable surface contamination for four groups of radionuclides plus tritium. For the general case of materials that may have been contaminated with a variety of radionuclides at LLNL, the material will be evaluated for alpha, beta and tritium surface contamination. Materials will be surveyed using alpha and beta/gamma field survey meters to measure the total (fixed and removable) surface contamination levels of alpha and beta/gamma emitting radionuclides. The removable contamination is measured by swiping a known area (typically 100 cm^2) for alpha/beta and tritium. The results of the field surveys and swipes are compared against the surface contamination release limits of Table 3. Materials with known surface contamination shall be decontaminated to levels that are as low as is reasonably achievable per guidance in LLNL ES&H Manual Document 20.2. Swipe and survey results must be documented and traceable to the material being released. Instrumentation used for swipe and survey must be sensitive enough to meet the limits presented in Table 3.

Table 3. Authorized Release Limits for Surface Contaminated Wastes (dpm/100 cm^2)[a, b] (From: DOE 5400.5)

Radionuclides[c]	Avg[d,e]	Max[d,e]	Removable[f]
Group 1--Transuranics, ^{125}I, ^{129}I, ^{227}Ac, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{231}Pa	100	300	20
Group 2--Th-natural, ^{90}Sr, ^{126}I, ^{131}I, ^{133}I, ^{223}Ra, ^{224}Ra, ^{232}U, ^{232}Th	1,000	3,000	200
Group 3--U-natural, ^{235}U, ^{238}U, associated decay products, alpha emitters	5,000	15,000	1,000
Group 4 -- Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above[g]	5,000	15,000	1,000
Tritium (applicable to surface and subsurface)[h]	N/A	N/A	10,000

a The values in this table (except for tritium) apply to radioactive material deposited on but not incorporated into the interior or matrix of the property. No generic concentration guidelines have been approved for release of material that has been contaminated in depth, such as activated material or smelted contaminated metals (e.g., radioactivity per unit volume or per unit mass). Authorized limits for residual radioactive material in volume must be approved separately.

b As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c Where surface contamination by both alpha-emitting and beta-gamma-emitting radionuclides exists, the limits established for alpha-emitting and beta-gamma-emitting radionuclides should apply independently.

d Measurements of average contamination should not be averaged over an area of more than 1 m2. Where scanning surveys are not sufficient to detect levels in the table, static counting must be used to measure surface activity. Representative sampling (static counts on the areas) may be used to demonstrate by analyses of the static counting data. The maximum contamination level applies to an area of not more than 100 cm^2.

e The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 millirad per hour (mrad/h) and 1.0 mrad/h, respectively, at 1 cm.

f The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination of objects on surfaces of less than 100 cm^2 is determined, the activity per unit area should be based on the actual area, and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate the total residual surface contamination levels are within the limits for removable contamination.

g This category of radionuclides includes mixed fission products, including the ^{90}Sr that is present in them. It does not apply to ^{90}Sr that has been separated from the other fission products or mixtures where the "Sr has been enriched.

h Measurement should be conducted by a standard smear measurement but using a damp swipe or material that will readily absorb tritium, such as polystyrene foam. Property recently exposed or decontaminated should have measurements (smears) at regular time intervals to prevent a buildup of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in group 4 do not apply to tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure nonremovable fractions and residual tritium in mass will not cause exposures that exceed DOE dose limits and constraints.

Determination of added radioactivity for surface contaminated wastes:

Swipe/survey results which meet Table 3 may be evaluated for a Rad-Dec. Documented swipe/survey results which are non-detect may be issued an NRA determination. Swipe/survey results which indicate the presence of measurable radioactivity above background will be issued a Rad-Dec of “Rad-Added” or “Contaminated with Residual Radioactivity”. Suspect materials with inaccessible areas will not receive an NRA determination.

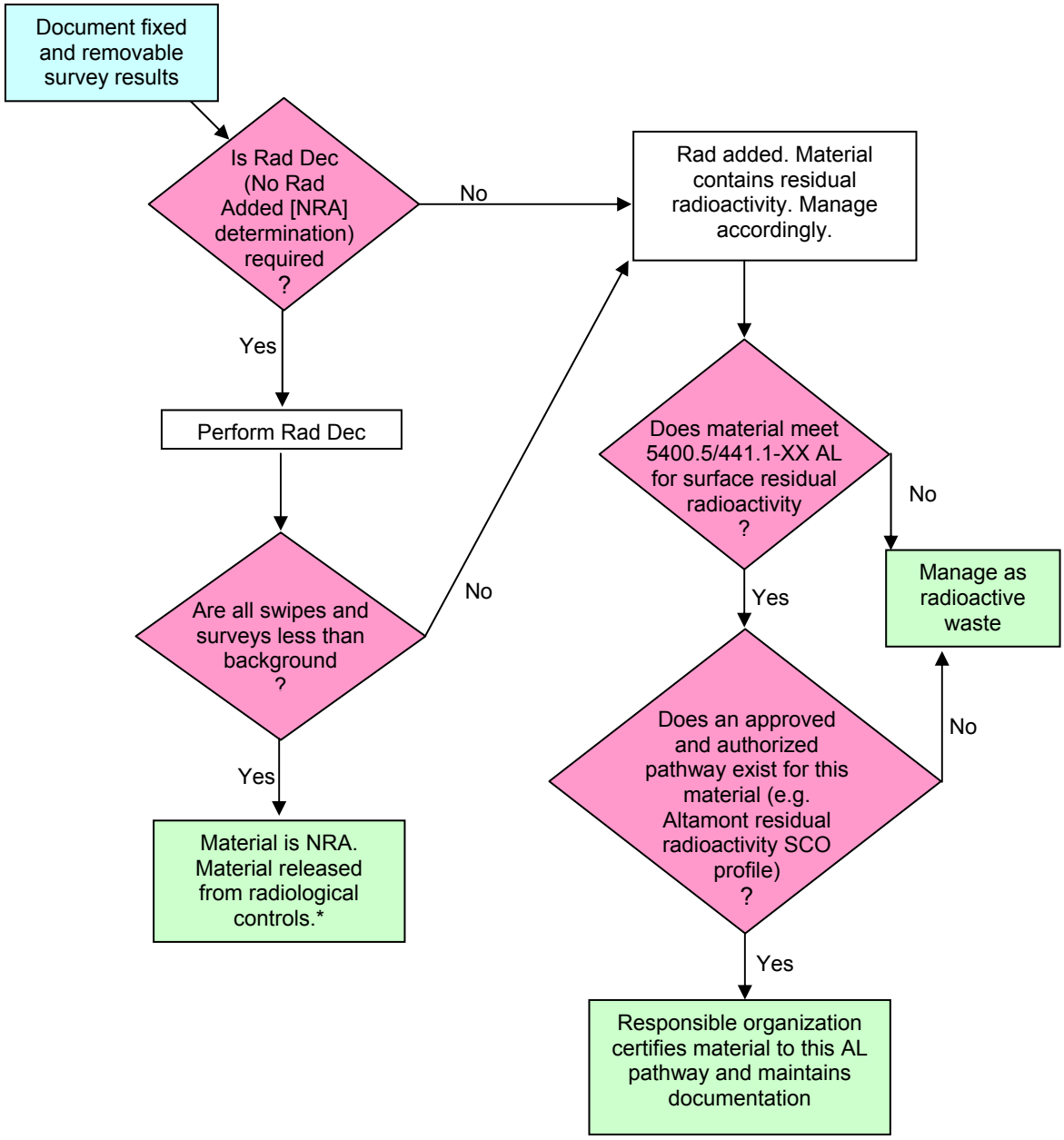
Swipe/survey results declared as “Rad-Added” or “Contaminated with Residual Radioactivity” may be managed through the AL process or managed as radioactive waste.

Swipe/survey results with measurable radioactivity above background but meeting Table 3 are considered “Rad-Added” or “Contaminated with Residual Radioactivity”, but may not need to be managed as radioactive waste. These materials are considered to be contaminated with residual radioactive material and may be managed through the AL process. DOE has authorized release of materials contaminated up to Table 3 limits as an approved Authorized Limit (References 3 and 4). This DOE concurrence does not imply acceptance or concurrence on the limits by the receiving facility or the receiving facilities regulators as may be required.

The following flowchart outlines the general process for evaluating potential surface contaminated objects for DOE-added radioactivity.

General Process for Evaluating Potential Surface Contaminated Objects (SCO) for DOE-Added Radioactivity

(Includes permeable, swipeable matrices potentially contaminated with tritium only (e.g., wood, wallboard, concrete slabs) which may be released under the Authorized Limit (AL) for SCO.)



* Does not include permeable, swipeable matrices contaminated with tritium. To receive an NRA determination for these materials, they must be evaluated for volumetric contamination.

Notes:

1. DOE metals moratorium is still in effect.
2. SCO materials may be decontaminated to meet 441.1-XX.
3. SCO materials may be decontaminated to receive an NRA determination with the exception of permeable matrices contaminated with tritium.

XV. REVIEW

RHWM shall review this document on a triennial basis.

XVI. REFERENCES

1. Lawrence Livermore National Laboratory, *Criteria and Procedures for the Certification of Nonradioactive Hazardous Waste*, UCRL-AR-109662, 1992.
2. U.S. Department of Energy (DOE) document, *Performance Objective for Certification of Non-Radioactive Hazardous Waste* (EM-30, 1995).
3. DOE Order 5400.5, Chg 2, *Radiation Protection of the Public and the Environment*, latest revision.
4. DOE G 441.1-XX, *Control and Release of Property with Residual Radioactive Material*, Issued by Andy Lawrence May 01, 2002.
5. U.S. Department of Energy (DOE) memorandum, *Availability of Implementation Guide for the Control and Release of Property with Residual Radioactive Material for Use and Comment*, from Andy Lawrence, Director, Office of Environmental Policy and Guidance, to Distribution, dated May 1, 2002.
6. Lawrence Livermore National Laboratory. ES&H Manual, Document 20.2, *LLNL Radiological Safety Program for Radioactive Materials.* Appendix E, *Values for Establishing Sealed Radioactive Source Accountability and Radioactive Materials Posting and Labeling Requirements.*
7. U.S. Department of Energy, Memo from Daniel Nakahara to Richard Crawford, *Use of Nuclear Regulatory Commission (NRC) Guidelines for Shipment of Hazardous Waste for Disposal*, December 27, 1993.
8. DOE Order 435.1, Change 1, *Radioactive Waste Management*, Change 1, 7/9/99.
9. RHWM Controlled Procedure WIC 148, *Review of Radiochemical Data for Determination of Added Radioactivity,* latest revision.
10. U.S. Department of Energy (DOE) document, *Guide to Good Practice for Establishing Authorized Limits for the Release of Waste and Property Contaminated with Residual* Radioactivity, Project No.: ENVR-0012, Draft May 1999.
11. Statement of Work for Analytical Services in Support of Lawrence Livermore National Laboratory and Lawrence Livermore National Laboratory, February 2004.

12. U.S. Department of Energy, Research and Development Laboratory Working Group (RADWG) Analytical Chemistry Laboratory Committee, Document No. DOE/CH-9403, September 14, 1993.

13. Environmental Protection Department, Environmental Monitoring and Analysis Division, Radiation Analytical Sciences Section, Memo from Howard Hall to Bill Isherwood, Subject: *Report of the ad hoc Committee on Radiological Analyses of Soils and Preconstruction Debris*, April 15, 1992.

14. Lawrence Livermore National Laboratory, *Technical Basis Document for Criteria and Processes for the Certification of Non-Radioactive Hazardous and Non-Hazardous Wastes*, UCRL-TR-228108-REV-1, J. L. Dominick, June 29, 2007.

15. Lawrence Livermore National Laboratory, *Background Values of Gross Alpha and Gross Beta in Soil for Lawrence Livermore National Laboratory*, LLNL-TR-402360, G. Gallegos, March 2008.

16. ANSI/HPS N13.12-1999, *Surface and Volume Radioactivity Standards for Clearance*, August 31, 1999.

17. Lawrence Livermore National Laboratory, Memo from Kathy Shingleton to ES&H Team health Physicists, *Additional Guidance for Implementing DOE's Moratorium on the Release of Volumetrically Contaminated Metals and DOE's Suspension on the Unrestricted Release for Recycling of Metal from Radiological Areas,* June 29, 2001.